UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/761,477	01/20/2004	Shih-Ho Lin	67,200-1202	2913

7590 01/06/2006

TUNG & ASSOCIATES
Suite 120
838 W. Long Lake Road
Bloomfield Hills, MI 48302

EXAMINER	
ALEXANDER, MICHAEL P	

ART UNIT	PAPER NUMBER
1742	

DATE MAILED: 01/06/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/761,477	LIN ET AL.	
	Examiner	Art Unit	
	Michael P. Alexander	1742	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 November 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-3,7,10,13,15-17 and 19-28* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3,7,10,13,15-17 and 19-28* is/are rejected.

7)☐ Claim(s) ____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *20 January 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim(s) 1-3, 7, 10, 13, 15-17, and 19-28 is/are pending.

Claim Objections

Claims 20, 23, 25 and 28 are objected to because of the following informalities: the claims should depend from claim 17 instead of claim 18, which has been cancelled. Appropriate correction is required.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1-2, 13, 21-22, 24 and 26-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bajaj (US 2003/0201185) in view of Ting et al. (US 6,017,437).

Regarding claim 1, Bajaj teaches (abstract, 0004, 0007, 0008, 0024, Fig. 2a) a method which would inherently remove particles from a wafer surface comprising via openings (i.e. damascene openings) lined with a metal copper seed layer comprising

the steps of: providing an electrolyte which would inherently contain copper ions; immersing said wafer surface in the solution in spaced apart relation to an electrode; supplying a pulsed electrical current to said wafer and said electrode to result in a net removal of a portion of the metal seed layer prior to electroplating said metal to fill the via opening.

Still regarding claim 1, Bajaj does not specify rotating the wafer in the solution. However, Ting teaches (col. 5 line 55 – col. 6 line 4) that it is generally an accepted practice to rotate a wafer in a medium in order to ensure a more uniform distribution of the medium over the wafer surface. It would have been obvious to one of ordinary skill in the art to modify the method of Bajaj by rotating the wafer in the solution in order to ensure a more uniform distribution of the solution over the wafer surface as taught by Ting. Furthermore, the Examiner would like to comment that the claims of the instant application do not specify when the wafer is being rotated. Therefore, rotating the wafer during the electroplating would be within the scope of instant claim 1.

Regarding claim 2, Bajaj teaches (0007) applying a cathodic pulse to the seed layer immediately following each of the plurality of anodic pulses.

Regarding claim 13, Bajaj teaches (abstract, 0004, 0007, 0008, 0024, Fig. 2a) a method which would inherently remove particles from a copper layer on a wafer, comprising the steps of: providing an electrolyte solution which would inherently contain copper ions; immersing the wafer in the electrolyte solution; and applying a pulsed current with alternating polarity between the metal layer and an electrode to alternately electroplate and remove said metal to result in a net removal of the metal layer to form a

thinned metal layer; and carrying out an electroplating process to form a second metal layer on the thinned metal layer.

Still regarding claim 13, Bajaj does not specify providing rotational friction between the metal layer and the solution by rotating the wafer in the solution. However, Ting teaches (col. 5 line 55 – col. 6 line 4) that it is generally an accepted practice to rotate a wafer in a medium in order to ensure a more uniform distribution of the medium over the wafer surface. It would have been obvious to one of ordinary skill in the art to modify the method of Bajaj by rotating the wafer in the solution in order to ensure a more uniform distribution of the solution over the wafer surface as taught by Ting. Furthermore, the Examiner would like to comment that the claims of the instant application do not specify when the wafer is being rotated. Therefore, rotating the wafer during the electroplating would be within the scope of instant claim 13.

Regarding claims 21-22, Bajaj teaches (0024) that the method would not remove a substantial portion of the seed layer, which would inherently be less than about 200 angstroms.

Regarding claim 24, Bajaj teaches (0005) that the method would apply to sub-quarter micron sized high aspect ratio features, which would inherently be less than about 0.2 microns.

Regarding claims 26-27, Bajaj teaches (0008) that the metal seed layer would be a copper seed layer.

Claims 3, 7, 10 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bajaj et al. in view of Ting et al. as applied to claims 1 and 13 above, and further in view of Taylor et al. (US 2002/0056645).

Regarding claims 3, 7, 10 and 15, Bajaj does not specify that the solution would contain one of the claimed surfactants. However, Taylor teaches (0074, 0140) an electrolyte comprising polyethylene glycol of the molecular weight 2500-5000 and teaches that electroplating from the electrolyte gave superior results. It would have been obvious to one of ordinary skill in the art to combine the electrolyte of Taylor with the method of Bajaj in view of Ting because the electrolyte gives superior results.

Claims 17, 19, 23, 25 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bajaj (US 2003/0201185) in view of Taylor (US 2002/0056645) and Ting (US 6,017,437).

Regarding claims 17 and 19, Bajaj teaches (abstract, 0004, 0007, 0008, 0024, Fig. 2a) a method which would inherently remove particles from a via opening lined by a seed layer on a wafer, comprising the steps of: providing an electrolyte solution; and removing metal from the seed layer by applying a pulsed current with alternating polarity between said seed layer and an electrode to alternately electroplate and remove metal from said seed layer to form a thinned seed layer including inherently removing metal particles on said seed layer; then electroplating copper on said thinned seed layer to fill said via opening. Bajaj does not specify the composition of the electrolyte solution and does not specify providing rotational friction between the seed layer and the solution by rotating the wafer in said solution.

With respect to the composition of the electrolyte solution in claims 17 and 19, Taylor teaches (0074, 0140) an electrolyte comprising copper sulfate, sulfuric acid and polyethylene glycol and teaches that electroplating from the disclosed solution gave superior results. It would have been obvious to one of ordinary skill in the art to combine the electrolyte of Taylor with the method of Bajaj because the electrolyte gives superior results as taught by Taylor.

With respect to providing rotational friction in claims 17 and 19, Ting teaches (col. 5 line 55 – col. 6 line 4) that it is generally an accepted practice to rotate a wafer in a medium in order to ensure a more uniform distribution of the medium over the wafer surface. It would have been obvious to one of ordinary skill in the art to modify the method of Bajaj by rotating the wafer in the solution in order to ensure a more uniform distribution of the solution over the wafer surface as taught by Ting. Furthermore, the Examiner would like to comment that the claims of the instant application do not specify when the wafer is being rotated. Therefore, rotating the wafer during the electroplating would be within the scope of instant claims 17 and 19.

Regarding claims 23, 25 and 28, see the rejections of claims 21, 24 and 26 above.

Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bajaj in view of Taylor and Ting as applied to claim 17 above, and further in view of Bereza et al. (SU 1440636).

Regarding claim 20, Bajaj does not specify that the metal removed from the metal layer and the metal electroplated onto the metal layer in a ratio of from about 2 to

about 5 by weight of the metal. However, Bereza teaches (pages 1-2) that the effect of the cathodic pulse is to depassivated the surface. Since the length of the cathodic pulse is a result effective variable as taught by Bereza, it would have been obvious to one of ordinary skill in the art to modify the method of Bajaj in view of Taylor and Ting by selecting the desired length of cathodic pulse such that the metal removed from the metal layer and the metal electroplated onto the metal layer would be in a ratio of from about 2 to about 5 by weight of the metal as a routine optimization as taught by Bereza. See MPEP 2144.05 II.

Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hu et al. (US 2003/0209448) in view of Uzoh (US 6,492,262).

Regarding claim(s) 13, Hu teaches (0074, 0077, 0080, 0084) a method, comprising the steps of: providing an electrolyte solution comprising ions of copper; immersing the wafer in an electrolyte solution and providing rotating friction between the metal layer and the solution by rotating the wafer in the solution; and applying a pulsed current with alternating polarity between the metal layer and an electrode to inherently alternately electroplate and remove the metal from the metal layer to result in a net removal of the metal layer to form a thinned metal layer

With respect to the limitation that the method removes particles in claim 13, the Examiner asserts that the method would inherently remove particles from the metal layer on a wafer because the method includes mechanical polishing.

Still regarding claim 13, Hu does not specify carrying out an electroplating process to form a second metal layer on the thinned metal layer. However, Uzoh

teaches (see Fig. 4 and col. 4 lines 1-9) carrying out an electroplating process to form a second metal layer on said thinned metal layer in order to form a multilevel structure. It would have been obvious to one of ordinary skill in the art to modify the method of Hu by carrying out an electroplating process to form a second metal layer on said thinned metal layer in order to form a multilevel structure as taught by Uzoh.

Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hu et al. in view of Uzoh as applied to claim 13 above, and further in view of Taylor et al. (US 2002/0056645).

Regarding claim 15, Hu does not specify that the solution would contain one of the claimed surfactants. However, Taylor teaches (0074, 0140) an electrolyte comprising polyethylene glycol and teaches that electroplating from the electrolyte gave superior results. It would have been obvious to one of ordinary skill in the art to combine the electrolyte of Taylor with the method of Hu et al. in view of Uzoh because the electrolyte gives superior results.

Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hu et al. in view of Uzoh as applied to claim 13 above, and further in view of Bereza et al. (SU 1440636).

Regarding claim 16, Hu does not specify that the metal removed from the metal layer and the metal electroplated onto the metal layer in a ratio of from about 2 to about 5 by weight of the metal. However, Bereza teaches (pages 1-2) that the effect of the cathodic pulse is to depassivated the surface. Since the length of the cathodic pulse is a result effective variable as taught by Bereza, it would have been obvious to one of

ordinary skill in the art to modify the method of Hu et al. in view of Uzoh by selecting the desired length of cathodic pulse such that the metal removed from the metal layer and the metal electroplated onto the metal layer would be in a ratio of from about 2 to about 5 by weight of the metal as a routine optimization as taught by Bereza. See MPEP 2144.05 II.

Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hu et al. in view of Uzoh as applied to claim 13 above, and further in view of Rathore et al. (US 6,258,710).

Regarding claim 22, Hu does not specify that the metal layer is thinned by less than about 200 Angstroms. However, Rathmore teaches (col. 11 lines 1-14) that copper seed layers about 100-700 angstoms thick as opposed to conventional thickness of 1100-2000 angstroms would have higher electromigration resistance. It would have been obvious to one of ordinary skill in the art to modify the method of Hu by forming a copper seed layer of about 100 to 700 angstoms thick in order to have increased electromigration resistance. Therefore, since the method of Hu removes all of the seed layer, then the net removal would be about 100 to 700 angstroms, which overlaps with the claimed range of less than 200 angstroms, which is prima facie evidence of obviousness. See MPEP 2144.05 I.

Response to Arguments

Applicant's arguments with respect to claims 1-3, 7, 10, 13, 15-17, and 19-28 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Morrissey et al (US 2002/0000382) teach a method of electrolytically treating a seed layer using a pulsed current prior to electroplating onto the seed layer but the method would not result in a thinning or net removal of the seed layer. Guldi et al. (US 6,689,686) teach a method of electrolytically treating a seed layer that would result in a thinning or net removal of the seed layer but the method does not suggest using a pulsed current.

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Michael P. Alexander whose telephone number is 571-272-8558. The examiner can normally be reached on M-F 8:30-4:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Roy V. King can be reached on 571-272-1244. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

ROY KING
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700

mpd
mpa